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PCEP Requirements for WSON Routing and Wavelength Assignment

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Status of this Memo

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Abstract

This memo provides application-specific requirements for the Path Computation Element communication Protocol (PCEP) for the support of Wavelength Switched Optical Networks (WSON). Lightpath provisioning in WSONs requires a routing and wavelength assignment (RWA) process. From a path computation perspective, wavelength assignment is the process of determining which wavelength can be used on each hop of a path and forms an additional routing constraint to optical light path computation. Requirements related to optical impairments will be addressed in a separate document.

Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

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1. Introduction

[RFC4655] defines the PCE based Architecture and explains how a Path Computation Element (PCE) may compute Label Switched Paths (LSP) in Multiprotocol Label Switching Traffic Engineering (MPLS-TE) and Generalized MPLS (GMPLS) networks at the request of Path Computation Clients (PCCs). A PCC is shown to be any network component that makes such a request and may be for instance an Optical Switching Element within a Wavelength Division Multiplexing (WDM) network. The PCE, itself, can be located anywhere within the network, and may be within an optical switching element, a Network Management System (NMS) or Operational Support System (OSS), or may be an independent network server.

The PCE communications Protocol (PCEP) is the communication protocol used between PCC and PCE, and may also be used between cooperating PCEs. [RFC4657] sets out the common protocol requirements for PCEP. Additional application-specific requirements for PCEP are deferred to separate documents.

This document provides a set of application-specific PCEP requirements for support of path computation in Wavelength Switched Optical Networks (WSON). WSON refers to WDM based optical networks in which switching is performed selectively based on the wavelength of an optical signal.

The path in WSON is referred to as a lightpath. A lightpath may span multiple fiber links and the path should be assigned a wavelength for each link. A transparent optical network is made up of optical devices that can switch but not convert from one wavelength to another. In a transparent optical network, a lightpath operates on the same wavelength across all fiber links that it traverses. In such case, the lightpath is said to satisfy the wavelength-continuity constraint. Two lightpaths that share a common fiber link can not be assigned the same wavelength. To do otherwise would result in both signals interfering with each other. Note that advanced additional

multiplexing techniques such as polarization based multiplexing are not addressed in this document since the physical layer aspects are not currently standardized. Therefore, assigning the proper wavelength on a lightpath is an essential requirement in the optical path computation process.

When a switching node has the ability to perform wavelength conversion the wavelength-continuity constraint can be relaxed, and a lightpath may use different wavelengths on different links along its route from origin to destination. It is, however, to be noted that wavelength converters may be limited due to their relatively high cost, while the number of WDM channels that can be supported in a fiber is also limited. As a WSON can be composed of network nodes that cannot perform wavelength conversion, nodes with limited wavelength conversion, and nodes with full wavelength conversion abilities, wavelength assignment is an additional routing constraint to be considered in all lightpath computation.

In this document we first review the processes for routing and wavelength assignment (RWA) used when wavelength continuity constraints are present and then specify requirements for PCEP to support RWA.

The remainder of this document uses terminology from [RFC4655].

1.1. WSON RWA Processes

In [WSON-Frame] three alternative process architectures were given for performing routing and wavelength assignment. These are shown schematically in Figure 1.

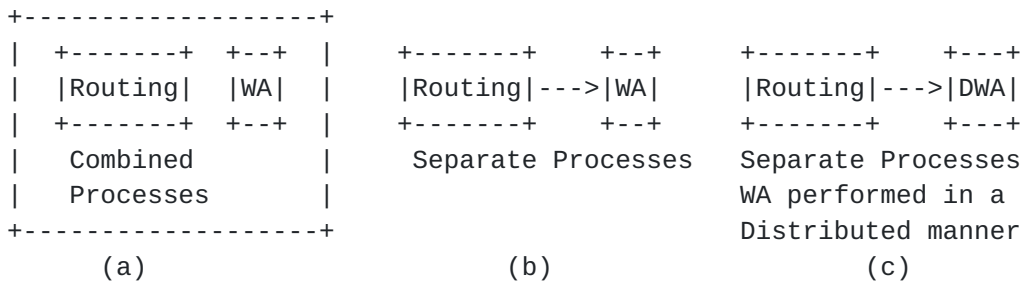

Figure 1 RWA process alternatives.

These alternatives have the following properties and impact on PCEP requirements in this document.

1. Combined Processes (R&WA) - Here path selection and wavelength assignment are performed as a single process. The requirements for PCC-PCE interaction with such a combined RWA process PCE is addressed in this document.

2. Routing separate from Wavelength Assignment (R+WA) - Here the routing process furnishes one or more potential paths to the wavelength assignment process that then performs final path selection and wavelength assignment. The requirements for PCE-PCE interaction with one PCE implementing the routing process and another implementing the wavelength assignment process are not addressed in this document.

3. Routing and distributed Wavelength Assignment (R+DWA) - Here a standard path computation (unaware of detailed wavelength availability) takes place, then wavelength assignment is performed along this path in a distributed manner via signaling (RSVP-TE). This alternative should be covered by existing or emerging GMPLS PCEP extensions and does not present new WSON specific requirements.

2. WSON PCE Architectures and Requirements

In the previous section we reviewed various process architectures for implementing RWA. In Figure 2 we reduce these alternatives to one typical PCE based implementation, which is referred to as Combined Process (R&WA). In Figure 2 we show the two processes of routing and wavelength assignment accessed via a single PCE.

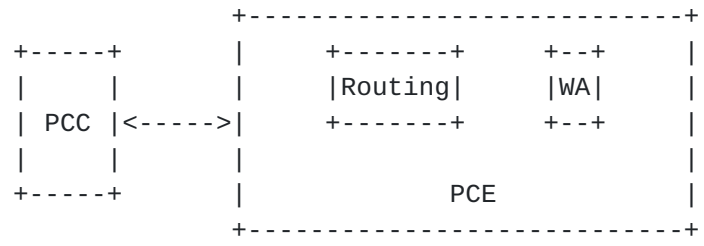

Figure 2 Combined Process (R&WA) architecture

2.1. RWA PCC to PCE Interface

The requirements for the PCC to PCE interface of Figure 2 are specified in this section.

2.1.1. A new RWA path request

1. The PCReq Message MUST include the path computation type. This can be: RWA, or only routing. This requirement is needed to differentiate between the currently supported routing with distribute wavelength assignment option and combined RWA.

2. The PCRep Message MUST include the route, and wavelengths assigned to the route. In the case where a valid path is not found, the PCRep Message MUST include why the path is not found (e.g., no route, wavelength not found, etc.)

2.1.2. An RWA path re-optimization request

1. For a re-optimization request, the PCReq Message MUST provide the path to be re-optimized and include the following options:

   a. Re-optimize the path keeping the same wavelength(s)

   b. Re-optimize wavelength(s) keeping the same path

   c. Re-optimize allowing both wavelength and the path to change

2. The corresponding PCRep Message for the re-optimized request MUST provide the Re-optimized path and wavelengths. In case that the path is not found, the PCRep Message MUST include why the path is not found (e.g., no route, wavelength not found, both route and wavelength not found, etc.)

2.1.3. Wavelength Range Constraint

For any PCReq Message that is associated with a request for wavelength assignment the requester (PCC) MUST be able to specify a restriction on the wavelengths to be used.

Note that the requestor (PCC) is NOT required to furnish any range restrictions. This restriction is to be interpreted by the PCE as a constraint on the tuning ability of the origination laser transmitter.

3. Manageability Considerations

Manageability of WSON Routing and Wavelength Assignment (RWA) with PCE must address the following considerations:

3.1. Control of Function and Policy

In addition to the parameters already listed in Section 8.1 of [PCEP], a PCEP implementation SHOULD allow configuring the following PCEP session parameters on a PCC:

- The ability to send a WSON RWA request.

In addition to the parameters already listed in Section 8.1 of [PCEP], a PCEP implementation SHOULD allow configuring the following PCEP session parameters on a PCE:

- The support for WSON RWA.
- The maximum number of synchronized path requests associated with WSON RWA per request message.
- A set of WSON RWA specific policies (authorized sender, request rate limiter, etc).

These parameters may be configured as default parameters for any PCEP session the PCEP speaker participates in, or may apply to a specific session with a given PCEP peer or a specific group of sessions with a specific group of PCEP peers.

3.2. Information and Data Models, e.g. MIB module

Extensions to the PCEP MIB module defined in [PCEP-MIB] should be defined, so as to cover the WSON RWA information introduced in this document. A future revision of this document will list the information that should be added to the MIB module.

3.3. Liveness Detection and Monitoring

Mechanisms defined in this document do not imply any new liveness detection and monitoring requirements in addition to those already listed in section 8.3 of [PCEP].

3.4. Verifying Correct Operation

Mechanisms defined in this document do not imply any new verification requirements in addition to those already listed in section 8.4 of [PCEP]

3.5. Requirements on Other Protocols and Functional Components

The PCE Discovery mechanisms ([RFC5089] and [RFC5088]) may be used to advertise WSON RWA path computation capabilities to PCCs.

3.6. Impact on Network Operation

Mechanisms defined in this document do not imply any new network operation requirements in addition to those already listed in section 8.6 of [PCEP].

4. Security Considerations

This document has no requirement for a change to the security models within PCEP [PCEP]. However the additional information distributed in order to address the RWA problem represents a disclosure of network capabilities that an operator may wish to keep private. Consideration should be given to securing this information.

5. IANA Considerations

A future revision of this document will present requests to IANA for codepoint allocation.

6. Acknowledgments

The authors would like to thank Adrian Farrel for many helpful comments that greatly improved the contents of this draft.

This document was prepared using 2-Word-v2.0.template.dot.

7. References

7.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC4655] Farrel, A., Vasseur, J., and J. Ash, "A Path Computation Element (PCE)-Based Architecture", RFC 4655, August 2006.

[RFC4657] Ash, J. and J. Le Roux, "Path Computation Element (PCE) Communication Protocol Generic Requirements", RFC 4657, September 2006.

[PCEP] Vasseur, JP., Ed. and JL. Le Roux, Ed., "Path Computation Element (PCE) communication Protocol (PCEP) - Version 1", RFC 5440, March 2009.

[PCEP-MIB] "PCE communication protocol(PCEP) Management Information Base", draft-ietf-pce-pcep-mib, work in progress.

7.2. Informative References

[WSON-Frame] Bernstein, G. and Lee, Y. (Editors), and W. Imajuku, "A Framework for the Control and Measurement of Wavelength Switched Optical Networks (WSON) with Impairments draft-bernstein-ccamp-wson-impairments, work in progress.

[WSON-IMP] Bernstein, G. and Lee, Y. (Editors), and D. Li, "Framework for GMPLS and PCE Control of Wavelength Switched Optical Networks", draft-bernstein-ccamp-wavelength-switched, work in progress.

[RFC5088] Le Roux, JL., Ed., Vasseur, JP., Ed., Ikejiri, Y., and R. Zhang, "OSPF Protocol Extensions for Path Computation Element (PCE) Discovery", RFC 5088, January 2008.

[RFC5089] Le Roux, JL., Ed., Vasseur, JP., Ed., Ikejiri, Y., and R. Zhang, "IS-IS Protocol Extensions for Path Computation Element (PCE) Discovery", RFC 5089, January 2008.

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